Working paper on Scalability Comparison of AODV and DSDV Routing Protocols in MANET's

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***Abstract* - Ad-hoc networks form instantaneously without the need of any infrastructure or centralized controller. This type of peer-to-peer system results that each node, or user, in the network can act as a data endpoint or intermediate repeater. Thus, all users work simultaneously to improve the reliability of network communications. These networks are also popularly called as "mesh networks" because the topology of network communications resembles a mesh. The redundant and the unnecessary communication paths provided by ad hoc mesh networks significantly improve the fault tolerance for the network. Also, the ability of the data packets to "hop" from one user to other effectively extends the network coverage area and provides a solution to defeat non-line of sight (LOS) issues.As mobile networking continues to experience increasing popularity; the need to connect large numbers of wireless devices will become more prevalent. Many recent proposals for ad hoc routing have certain characteristics which may limit their scalability to large networks. Mobile Ad Hoc Networks (MANETs) is a collection of wireless mobile nodes connected by wireless links forming a temporary network without the aid of any infrastructure or any centralized administration. Nodes within each other's radio range communicate directly via wireless links, while those that are far apart use other nodes as relays in a multi-hop routing fashion. These protocols typically suffer from a number of shortcomings, such as high routing overhead and limited scalability. The scalability of current on-demand and table driven routing protocols is evaluated through the selection of a representative from the class of protocols. The performance of the un-modified on-demand protocol and table driven routing protocol is compared with each of the scalability modifications. Based on the observations, conclusions can be drawn as to the expected scalability improvement which can be achieved by each modification. Our objective is to thoroughly capture and analyze the impact of scalability on MANET performance using reactive (AODV) routing protocol and proactive (DSDV) by varying number of source nodes in the MANET. For this, there is a plan to use Performance Metrics i.e. Throughput, Packet delivery Ratio and end to end delay to analyze the impact of scalability on Reactive and Proactive Routing Protocol category in MANET.**

***Keywords* - Manet, AODV, DSDV, Throughput, end to end delay, Packet Delivery ratio, NS-2 Simulator**

I. INTRODUCTION

Manet's

Mobile Ad Hoc Networks (MANETs) [1] has become one of the most popular areas of research today because of the challenges it pose to the related protocols. MANET is the upcoming technologies which make the users communicate without any physical infrastructure regardless of their location, that's why it is referred to as an ―infrastructure less network. They can have multi hop to the destination. These networks have various advantages like rapid deployment, robustness, flexibility and inherent support for mobility. This flexibility of self configuring and self administration makes it attractive for various applications like in military operations, wireless mesh networks; wireless sensor networks etc. Due to the wireless nature of Mobile Ad hoc networks, the routing protocol is a critical issue and challenges to make it more efficient and reliable. An ad-hoc network is self-organizing and adaptive. Devices in mobile ad hoc network should be capable of detecting the presence of other devices and perform necessary set up to facilitate communication and sharing of data and service. Ad hoc networking enables the devices to maintain connections to the network so that they can be easily added and removed to and from the network. The network topology may change rapidly and unpredictably over time due to nodal mobility. The network is decentralized, where network organization and message delivery must be executed by the nodes themselves. Because there is a frequent fluctuations in the topology, message routing is a problem in a decentralize environment. While the shortest path from a source to a destination based on a given cost function in a static network is usually the optimal route, this concept is difficult to extend in MANET. The set of applications for MANETs are highly diverse in nature, ranging from the large-scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources. Besides these applications that move from traditional infrastructure environment to the ad hoc context, a great deal of new services can and will be generated for the new environment. MANET is more exposed than wired network because of the mobile nodes, threats from compromised nodes inside the network, limited physical security, dynamic topology, scalability and lack of centralized management. Because of these vulnerabilities, MANET is more prone to malicious attacks.

The following figure raises the issue of symmetrical and asymmetrical links Node 1 is within the frequency range of node 3, then Node 3 is within frequency range of Node 1. This is a two-way communication, that's why the communication links are symmetrical. Although this assumption is not always valid, it is usually made because routing in asymmetrical network is relatively a difficult task. In certain cases, it is possible to find routes that could avoid asymmetrical links, since it is likely that these links frequently fail.

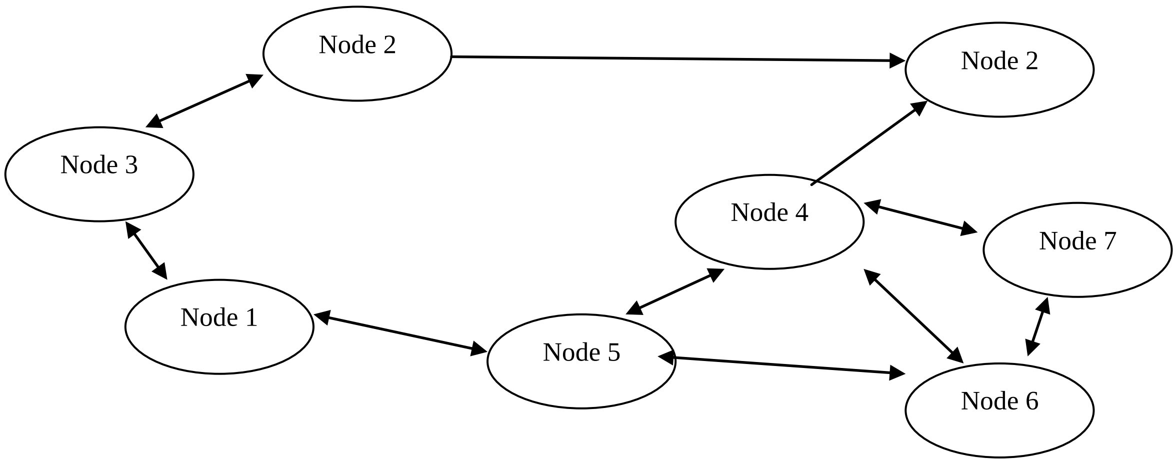

Fig 1 Mobile AD-hoc Network

II. Ad-hoc Networks Versus Mobile Ad-hoc Networks

Ad-hoc networks form instantaneously without the need of any infrastructure or centralized controller. This type of peer-to-peer system results that each node, or user, in the network can act as a data endpoint or intermediate repeater. Thus, all users work simultaneously to improve the reliability of network communications. These networks are also popularly called as "mesh networks" because the topology of network communications resembles a mesh.

The redundant and the unnecessary communication paths provided by ad hoc mesh networks significantly improve the fault tolerance for the network. Also, the ability of the data packets to "hop" from one user to other effectively extends the network coverage area and provides a solution to defeat non-line of sight (LOS) issues.

Mobile & wireless applications provide additional challenges for mesh networks as changes to the network topology are highly dynamic and widespread in nature. Such situations require the Mobile Ad hoc Networking (MANET) technology, so as to maintain the communication routes updated quickly and accurately. MANETs are self-forming, self-maintained, and self-healing, thereby allowing for extreme network flexibility. While MANETs can be completely self contained, they can also be tied to an IP-based global or local network (e.g. Internet or private networks).

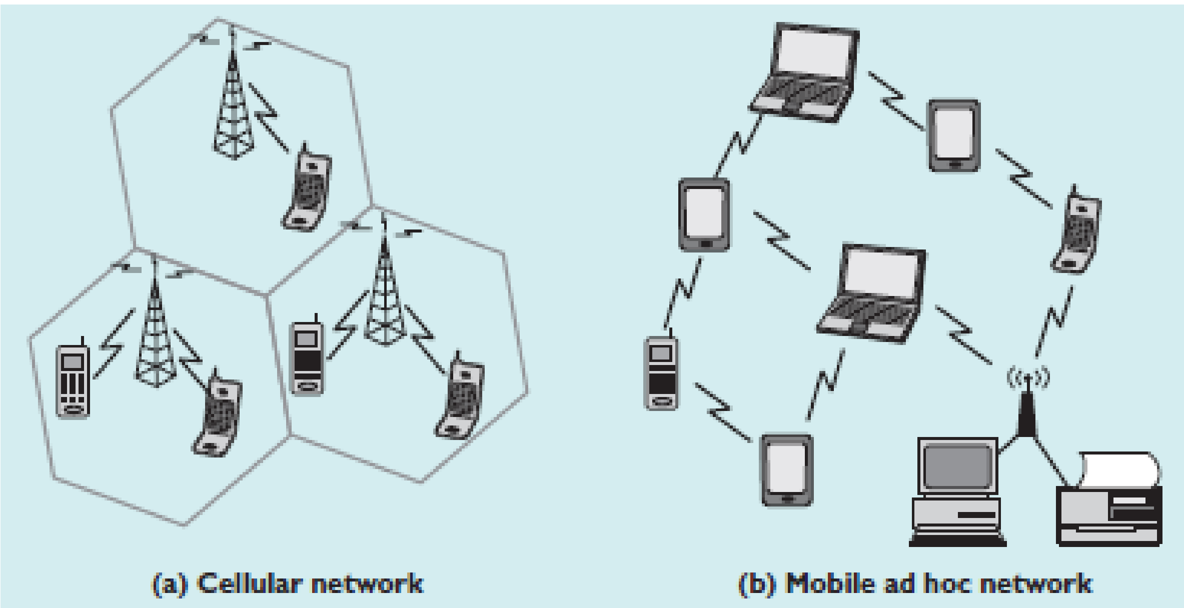

Fig 2 Cellular Network VS Mobile Ad-hoc network [2]

III. MANET Applications

- **Military Warfield:** Due to the great penetration of the information technology, military equipment now routinely contains some sort of computer equipment. Ad-hoc networking would help the military to take advantage of a common place network technology to maintain an information network between the soldiers, vehicles, and military information headquarters.

- **Emergency & Rescue Operations:** Ad hoc networks can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. The situation of emergency and rescue operations arises where non-existing or damaged communications infrastructure and rapid deployment of a communication network is needed. Information is relayed from one rescue team member to another over a small hand held called a walkie-talkie. Other commercial scenarios include e.g. ship-to-ship ad hoc mobile communication, law enforcement, etc.

- **Local Level:** Ad hoc networks can provide an instant and temporary multimedia network using notebook computers or palmtop computers to spread and share information among participants at e.g. conference or classroom. Another appropriate local level application might be in home networks where devices can communicate directly to exchange information. Similarly in other civilian environments like taxicab, sports stadium, boat and small aircraft, mobile ad hoc communications will find many applications.

- **Personal Area Network (PAN):** Short-range MANETs can simplify the intercommunication between various mobile devices (such as a PDA, a laptop, and a cellular phone) to a great extent. Tedious wired cables are replaced with wireless connections. Such an ad hoc network can also extend the access to the Internet or other networks by mechanisms e.g. Wireless LAN (WLAN), GPRS, and UMTS. The PAN is potentially a promising application field of MANET in the future pervasive computing context.

Routing Protocols

Routing is the most fundamental and critical research issue in MANET and must deal with limitations such as high power consumption, low bandwidth, high error rates and unpredictable movements of nodes.

Mobile Ad Hoc Networks can be divided into Table-Driven and On-Demand Routing protocol where Table Driven protocols are proactive and maintain a routing table and On-Demand are active and do not maintain a routing table. Generally, current routing protocols for MANET can be categorized as follows:

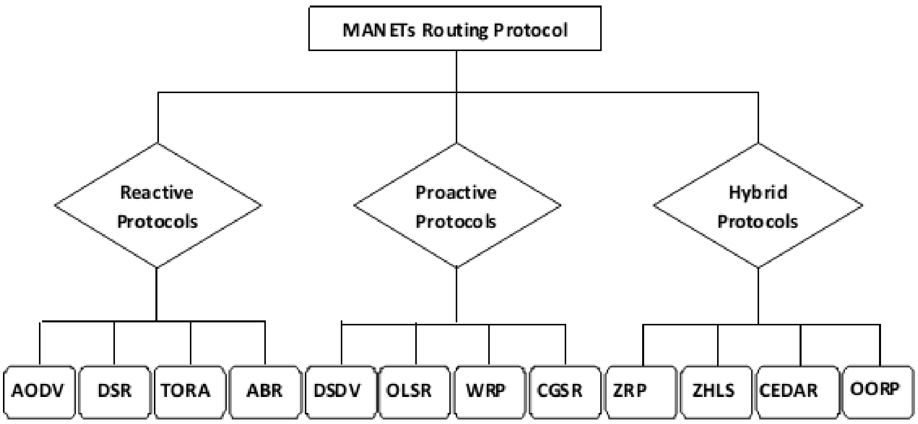

Fig 3 MANET Routing Protocols [3]

Destination-Sequenced Distance Vector

DSDV is one of the most popular table-driven routing algorithms [4, 5] for MANETs based on the Bellman-ford algorithm. The improvement made to the Bellman-Ford algorithm includes freedom from loops in routing table by using sequence numbers .Each node acts as a router where a routing table is maintained and periodic routing updates are exchange, even if the routes are not needed. A sequence number is allotted with each route or path to the destination to prevent routing loops. Routing updates are exchanged even if the network is idle which uses up battery and network bandwidth. Thus, it is not beneficial for highly dynamic networks. DSDV routing protocol maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number allotted by the destination node. The sequence number is used to distinguish unused routes from new ones and thus avoid the formation of unnecessary loops. So, the update is both time-driven and event-driven. The routing table update can be sent in two ways:

- A "full dump"
- An incremental update.

Advantages of DSDV

- DSDV protocol guarantees loop free paths.
- Count to infinity problem is reduced in DSDV.
- The extra traffic can be avoided with incremental updates instead of full dump updates.

Disadvantages of DSDV

- Wastage of bandwidth due to unnecessary advertising of routing information even when there is no change in the network topology.
- DSDV doesn't support Multi path Routing.

- It is hard to determine a time delay for the advertisement of routes.

Ad-hoc On-demand Distance Vector

Ad-hoc On-demand Distance Vector (AODV) [6] routing protocol is essentially a combination of both DSR and DSDV protocol. It borrows the basic on-demand mechanism of Route Discovery and Route Maintenance from DSR protocol, plus the use of hop-by-hop routing, sequence numbers, and periodic beacons from DSDV protocol. The AODV protocol [7] is loop-free and avoids the count-to-infinity problem by the use of sequence numbers. AODV protocol uses a simple request-reply mechanism for route discovery. Source node require a route to sends a Routes Request message to its neighbours. Source address and Request ID fields uniquely identify the ROUTE REQUEST packet to allow nodes to discard any duplicates they may receive. Sequence number of source and the most recent value of destination sequence number that the source has seen and the Hop count field will keep track of how many hops the packet has travelled. When source include destination sequence numbers in its route request that actually last known destination sequence number for a particular destination. Every intermediate nodes store most recent sequence number of source. If a neighbour has a route to destination then it informs the source node. If neighbours have no route then it rebroadcast RREQ and increment hop count. Eventually a route must be found if exists. In reverse path calculation, all nodes remember source of the RREQ. When a route is found then it working backwards, route is discovered. The receiver looks up the destination in its route table. To test freshness it compares destination sequence number, if RREQ packet destination sequence number is greater than the Route destination sequence numbers assumes route is still present and remains unused. If route is found Route Reply (RREP) message is returned to source. The protocol uses different messages to discover and maintain links:

Route Requests (RREQs)

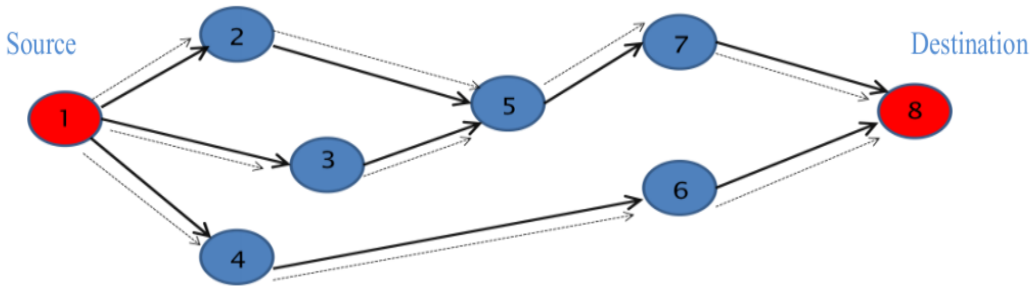

Fig 4 Propagation of route request Packet [6]

Route Replies (RREPs)

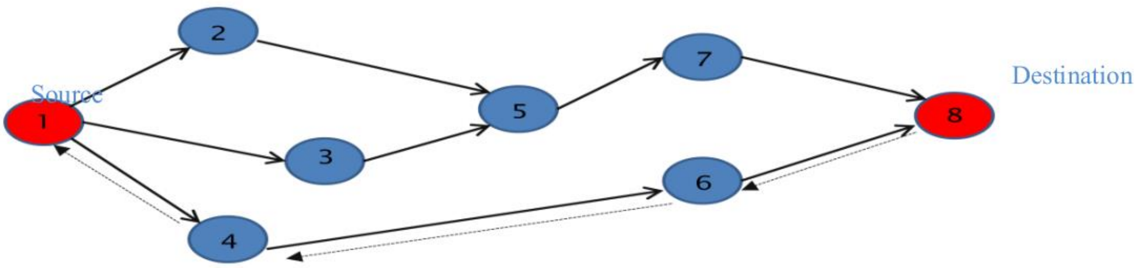

Fig 5 Propagation of route Reply Packet [6]

Route Errors (RERRs)

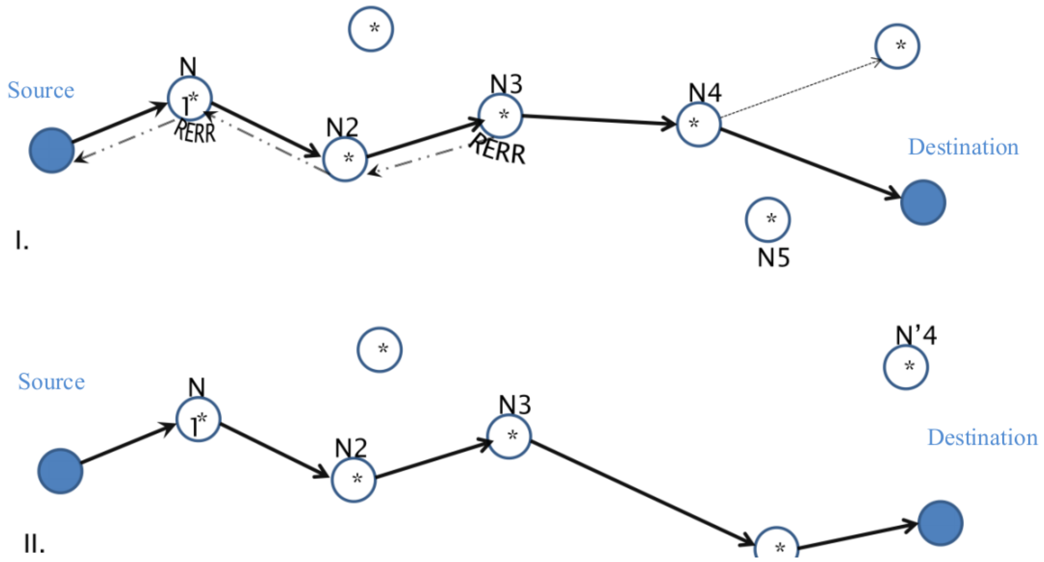

Fig 6 Route Error and II. Route Maintenance [6]

Advantages

- Routes are established on demand and destination sequence numbers are used to find the latest route to the destination.
- Lower delay for connection setup.

Disadvantage

- AODV does not allow handling unidirectional links.
- Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.
- Periodic beaconing leads to unnecessary bandwidth consumption

IV. Scalability Issues for AODV & DSDV Routing Protocols

A routing protocol is considered scalable if it is applicable to large-scale wireless networks without having serious deprivation on the routing performance. A scalable routing protocol is suggested to have algorithms to reduce performance deprivation scaled to large networks. Due to its convenience, larger wireless networks will be required as the demand for wireless technology. Therefore, scalability of routing protocols is critical [8]. Scalability is not only determined by the size, but also the ability to sustain networks of various density and mobility. Wireless networks of various density and mobility will have different impact on the performance deprivation [9, 10].

For this, we compare an ad hoc network in an office and an ad hoc network in a military war field practice. An ad hoc network in an office is normally dense. Nodes in this network hardly move whereas ad hoc networks for military war field practice are sparsely distributed and they move together frequently. Ad hoc networks in an office are facing serious network congestion because nodes are very near to each other. As the nodes broadcast their control message, there is a high probability of a broadcast storm occurring consequently degrading routing performance. Due to the high mobility characteristics of ad hoc networks for the military war field training, link breakage are often encountered [11]. Link breakage will increase the data delivery latency as time is taken to repair a broken link. It may also cause a network to split when a portion of nodes from the network loses connection to another portion of nodes. The density and mobility of a network have significant impact on the scalability of the routing protocol. Simulations for the ad hoc wireless network with different densities are conducted. The results of the simulations show that the number of collisions increase as the density of the network grows. A different mobility model is used for simulations to investigate the impact of mobility on routing performance. The results show that routing performance may vary drastically across different mobility models.

The scalability of AODV and DSDV routing protocols can be measured by the following dimensions which are discussed as follows [12]:

Packet Delivery Ratio

This is defined as the ratio of the number of data packets received by the destinations to those sent by the CBR sources.

Throughput

Throughput is the number of packet that is passing through the channel in a particular unit of time. This performance metric show the total number of packets that have been successfully delivered from source node to destination node and it can be improved with increasing node density.

The average end to end Delay

A specific packet is transmitting from source to destination node and calculates the difference between send times and received times. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric .This is defined as the delay between the time at which the data packet was originated at the source and the time it reaches the destination.

Data packets that get lost en route are not considered. Delays due to route discovery, queuing and retransmissions are included in the delay metric. The metrics are measured against various mobility scenarios and with varying number of data connections.

V. PROBLEM FORMULATION

Keeping in view the past work available on the subject, it has been observed that there is still some need to model and analyze the impact of scalability in Ad hoc On Demand Distance vector (AODV) and Destination-Sequenced Distance-Vector Routing (DSDV) in MANETs. Unlike the proactive routing, the reactive routing is simply started when nodes desire to transmit data packets. These protocols obtain the necessary path when it is required, by using a connection establishment process. Hence these protocols do not exchange routing information periodically.

We have selected one protocol from the category of Reactive Routing Protocol and other from the Proactive or Table driven Routing for the work. AODV protocol favors the least congested route instead of the shortest route and it also supports both unicast and multicast packet transmission even for nodes in constant movement. It also responds very quickly to the topological changes that affects the active route. AODV does not put any additional overheads on data packets as it does not make use of source routing. So the AODV Routing protocol has been selected which is one of the efficient Reactive Routing Protocol. Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad-hoc mobile networks. The main effort has been to solve the routing loop problem.

The objective is to analyze the performance and scalability of the two protocols AODV (reactive), DSDV (proactive) based on various network parameters such as end-to-end delay, throughput, packet delivery ratio, normalized routing load under the dynamic environment by increasing the number of sending nodes and decreasing the number of receiving nodes by keeping the total number of nodes fixed. The simulation work is done using the NS-2 simulator. Simulation is performed by once varying the resources and keeping the number of nodes fixed and in the other scenario the vice versa situation and analyze the performance of the network with AODV and DSDV routing protocols..

Throughput: The average rate at which the total number of data packet is delivered successfully from one node to another over a communication network is known as throughput. The result is found as per KB/Sec. It is calculated by

Throughput= (number of delivered packet * packet size) / total duration of simulation.

Packet delivery Ratio: This is the ratio of total number of packets successfully received by the destination nodes to the number of packets sent by the source nodes throughout the simulation.
End-to-end delay means the time required for a packet to be traversed from source to destination in the network and is measured in seconds.
For the same, the NS-2 simulator is used to implement the scalability check for the DSDV & AODV routing protocols, and the structure of the simulator is given below:

NS-2 Structure

To simulate the network, user has to program with OTCL script language to initiate an event scheduler and set up the network topology using the network objects and tell traffic sources when to start and stop transmitting packets through the event scheduler. OTCL script is executed by NS-2. Figure 7 shows the simplified user view of NS.

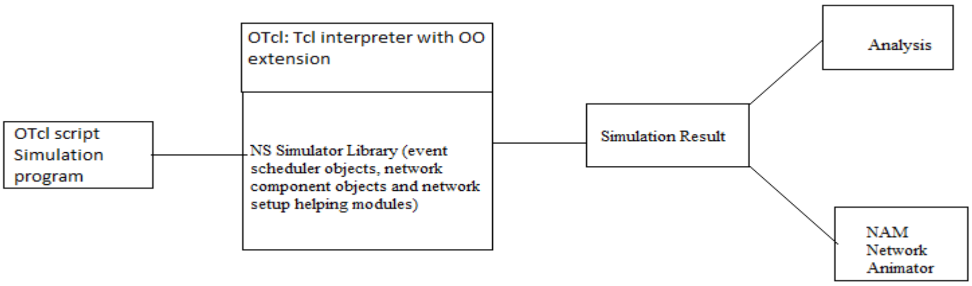

Fig 7 Simplified user's view of NS [13]

VI. CONCLUSION

In this paper, the issues regarding the scalability of the AODV & DSDV protocols are analyzed which are yet to be tested through the performance metrics i.e: throughput, packet delivery ratio and end to end delay through the use of NS-2 simulator. It has been concluded that the Manet's have the wide range of applications, and can be routed through the various reactive and proactive routing protocols which are discussed in the paper. The scalability is the critical issue for the successful implementation of these Manet networks and increases the efficiency of the Manet applicability in the various crucial areas.

VII. FUTURE SCOPE

The future of ad- hoc networks is challenging. It gives the vision of anytime, anywhere and cheap communications. Before these imagined scenarios can come true, large amount of work has to be done in both theoretical research and implementation.

We tried to study and analyze the impact of scalability in MANETs using two different routing protocols viz AODV, DSDV, by generating the traffic using the CBR .Analysis of the same protocol with larger number of nodes, greater number of channels with added security is considered necessary to the future enhancement. The same scenarios need to be tested for the other ways of generating traffic i.e. exponential or the Poisson. There is also need to analyze scalability in other MANETs routing protocols and find out the best routing protocol from each category in terms of scalability.

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